work and vegetation two or three weeks backward. The consensus of opinion was that a large acreage of winter grain had been killed and that all fruit had been more or less injured, and peaches seriously.—*T. F. Townsend.*

Porto Rico.—Weather generally favorable for all crops. Sugar making continued without interruption and the grade of juice obtained was generally satisfactory. Young canes were in excellent condition. Coffee trees continued blossoming; early blossoms badly injured by the heavy rains of March and the crop will be light. Rice, beans, corn, and cotton planted and some beans and corn harvested. Oranges became scarce. Pineapples and mangoes appeared in the markets. Pasturage was good.—*E. C. Thompson.*

South Carolina.—Steady low temperatures and a deficient rainfall were favorable for planting operations, which advanced farther than usual, but conditions were unfavorable for germination and growth, so that stands of corn, cotton, and rice were generally poor. Cotton planting was nearly finished, but only a small portion came up during the month. The normal development of truck, oats, wheat, and tobacco was retarded. Peaches, apples, plums, and other fruits were not affected.—*J. W. Bauer.*

South Dakota.—By the 30th the seeding of oats and spring wheat was finished in the southern and near completion in the middle counties, and wheat seeding was well advanced in the northern counties, with early sown grain coming up well and the medium late sown germinating favorably. Spelt and rye seeding was fairly well advanced and potato planting and gardening were begun. Grass was very backward, but by the close of the month afforded some grazing.—*S. W. Glenn.*

Tennessee.—The month was generally favorable for farm work, but the low temperature caused poor germination of seeds and slow growth of crops; however, wheat and spring oats improved greatly. Corn and cotton were mostly planted by the end of the month, but were coming up slowly; tobacco plants were small. Frosts during the first three weeks damaged garden crops and fruits, but there was a good prospect for apples, and in some localities peaches promised a fair crop.—*H. C. Bate.*

Texas.—Frequent cool waves occurred during the month, and on the morning of the 10th light frost was reported down to the coast region. The rainfall over the eastern half of the State was well distributed and sufficient to keep the ground in good condition; that over the western half was very light and afforded only temporary relief from the drought that had prevailed over that section for several months. The planting of cotton progressed rapidly and was nearly completed in the eastern half by the close of the month; good stands were generally secured, but the cool weather interfered with growth and the frost of the 10th did considerable damage to plants on lowlands. Corn made good growth and had received its first cultivation. Wheat, oats, barley, and rye made steady improvement, but were still much below the average condition in the western portion. Fall wheat and oats were heading. Rice sowing progressed rapidly and good stands were generally secured. Sugar cane made good growth. Hay and forage crops did well. The fruit crop was promising.—*L. H. Murdoch.*

Utah.—The temperature was slightly above normal, while precipitation was deficient. Farm work was backward until the last week when the weather was favorable for rapid progress. At the close of the month the seeding of spring wheat was well advanced. Beet planting was also under rapid headway. Fall wheat was doing well. Lucerne was generally in good condition and so was fruit. Ranges were good and cattle thriving. Sheep shearing was in progress with satisfactory clip.—*R. J. Hyatt.*

Virginia.—Crop conditions were not satisfactory. The weather was generally unseasonably cool; severe and general frosts in last decade did great injury to fruit bloom, especially peach, pear, plum, and cherry, and to young vines and berries. Preparation of land for spring crop was delayed, and gardens and pastures were later than usual. Winter wheat improved during the month and a considerable acreage of spring oats was seeded. Winter oats were in poor condition.—*Edward A. Evans.*

Washington.—The month was considerably above the average in warmth and scarcely as wet as the average April. Crops made no advancement, and no progress was made in farm work until the warm spell from the 8th to 18th, when all crops grew rapidly and plowing and seeding were rushed. The remainder of the month was showery, so that work was delayed and was too cool for rapid growth. At end of month fall wheat appeared to be in excellent condition.—*G. N. Salisbury.*

West Virginia.—Cold, cloudy, rainy weather prevailed during the month, and killing frosts were frequent. Vegetation made little progress, but plowing was pushed rapidly. At the close of the month, wheat and rye were improving somewhat, and meadows and pastures were making some growth; but little gardening had been done; stock was in fair condition, and had mostly been turned out. Although some early fruit was injured, the prospects for a good fruit crop were excellent.—*E. C. Vose.*

Wisconsin.—Cold and cloudy during first and second decades with rain and snow at frequent intervals, and a severe cold wave on the 16th; decidedly warmer weather during the third decade. Much spring grain was sown during the last week. Winter wheat and rye were injured by alternate freezing and thawing, but improved during latter part of month. Standard varieties of apples, plums, cherries, cranberries, and strawberries wintered well, but blackberries and raspberries, where unprotected, were badly killed.—*W. M. Wilson.*

Wyoming.—By the close of the month plowing and seeding were well advanced or completed over the earlier sections of the State, but hardly begun over the later sections. Grass had made good progress and the range was supporting stock over much of the State. Cattle and sheep were in excellent condition, and losses during winter were unusually light.—*W. S. Palmer.*

SPECIAL ARTICLES.

APPLICATION OF SALTS OF RADIUM TO THE STUDY OF ATMOSPHERIC ELECTRICITY.[1]

By TH. MOUREAUX, director of the observatory, Parc St. Maur.
[Translated by Miss R. A. Edwards.]

In current observations of atmospheric electricity, the value of the potential of the air is generally obtained by means of dropping water. This method, perfect in warm countries, is impracticable in our climate on account of the freezing of the water, the receiver, in many cases, being installed under the eaves of elevated buildings, in a place devoid of means of heating. Attempts have been made to protect the stem of the dropper from freezing, chiefly by means of a covering of wool, or by adding to the water a certain quantity of alcohol or of glycerine; but these means present rather serious difficulties in practise. In fact, the registering of variations of the potential is frequently interrupted in winter, at least during severe cold.

The discovery of the salts of radium by Professor and Mrs. Curie places in the hands of physicists a new method, applicable to all places and in all seasons. Professor Curie having had the kindness to place at our disposal some samples of salts of radium of different degrees of activity, we have successively executed a comparison between them and the water dropper now in use. The method adopted for these experiments is as follows: In a copper disk about four centimeters in diameter and two millimeters in thickness, Professor Curie hollowed out to a depth of half the disk's thickness a cavity 15 millimeters in diameter; at the bottom of this cavity he placed a thin sheet of asbestos, on which was placed a decigram of radium-bearing chloride of barium. A plate of aluminum about 1/10 millimeters in thickness was then carefully soldered to the copper disk, in such a manner as to hermetically seal the capsule thus formed. On the face of the disk opposite the aluminum plate was soldered a copper tube which fitted exactly the ordinary tube of the water reservoir at its free extremity. The value of the potential can then be ascertained as one wishes, either by means of radium or by means of the water dropper at two points as near as possible to each other.

Experiments were made at the observatory of Parc Saint-Maur during the months of March and April, 1903, with this apparatus. Three capsules were studied successively. In one, one of the first samples of radium obtained from Professor and Mrs. Curie in 1899 was used. Its radio-activity was not determined, but the experiment showed that the activity of this salt was not sufficient. In fact, the needle of the electrometer established equilibrium very slowly with the atmospheric potential. Rapid variations, for example, were considerably weakened; moreover, the portions of the registered curve indicated constantly a potential clearly less than that indicated by the water dropper; and, finally, the return to zero was extremely slow. The second capsule contained radium-bearing chloride of barium, of activity 5000 times that of uranium. The curves obtained with this second sample did not differ materially from the preceding; they showed that here also the radio-activity was insufficient to guarantee that the registered values were equal to the real value of the potential near the capsule, and, on account of the slowness of the move-

[1] Annuaire de la Société Météorologique de France, Janvier, 1904, pp. 9–11.

ment of the needle of the electrometer, the details of the variations were equally reduced or altogether suppressed. Finally, the third capsule contained a decigramme of radium-bearing chloride of barium 30,000 times that of uranium. This radio-active power gave to the observed variations of the potential a sensitiveness as great as did the water dropper.

This third capsule was placed at the extremity of the tube, and the potential was taken alternately, during regular intervals, with the radium and the water dropper. In both cases the state of equilibrium and the return to zero were reached with equal rapidity; the same details were obtained with radium and with the water dropper, and at the moment when either apparatus was substituted for the other the agreement of the curves was perfect. The experiment was prolonged during several days, and gave constantly the same results; the capsule has consequently been put into active use; tests made from time to time have shown that the radium bearing salt loses none of its energy. But after eight months of exposure to the air it has been ascertained that the aluminum plate alters with the weather, under the influence of the radiations from the radium, and does not sufficiently protect the salt from changes of humidity. Professor Curie thought that a good varnish would probably suffice to protect the contents of the capsule from variations of atmospheric humidity; the experiment was made by spreading over the capsule several thicknesses of special varnish used at carriage factories for fine carriages. This varnish, almost impervious to changes of weather, assures a perfect and durable protection. Moreover, it has the advantage of offering less resistance than the aluminum plate to the radiations of radium, so that by doing away with this plate, in some form of capsule that may be finally adopted, a salt of less radio-activity, obtainable at a more reasonable price, could probably be used. Experiments are continuing in this line under the direction of Professor Curie.

This process possesses then all the requirements for efficiency, providing the salt is endowed with proper radio-activity and that it is perfectly protected from the influence of humidity.

The advantages in using salts of radium in observations of atmospheric electricity are numerous. We will cite the principal ones: The constancy of the height above ground of the point where the potential is taken; facility in raising this point so as to be above buildings, trees, and, in a word, above all kinds of obstacles that by modifying the shape of equipotential curves greatly impair their value as useful observations; the total suppression of breaks resulting from stoppage in dropping, due to impurities in the water or to freezing temperature; less frequent personal attention; the abolishing of the water reservoir and, consequently, considerable diminution in the expense of installation and of maintenance; extension of the method to the polar regions, where the study of these phenomena is particularly interesting.

In a letter describing his apparatus more fully, M. Moureaux says:

The apparatus with which I made these observations, and which was constructed for me by Professor Curie himself, is described briefly in the Annuaire of the Meteorological Society of France. The capsule, as it is called therein, is represented in section in the accompanying figure.

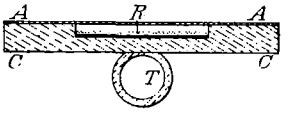

FIG. 1.

CC is a disk 32 millimeters in diameter and 3 millimeters in thickness. It is cut away to a depth of one-half its thickness at *R*, leaving a circular cavity 15 millimeters in diameter. On the opposite side of *T* there is soldered a tube of copper, which is held in place by friction at any point along the tube that carries the water used in the water-dropping collector. At the base of the cavity there is placed a thin sheet of the finest sort of asbestos, known as amianthus or earth flax, which is represented by the heavy black line. This is intended to keep the radium salt in place, since on this sheet of amianthus there is placed one decigram of the radio-active chloride of barium, having a strength of 30,000, and represented on the diagram by the dots at *R*. Finally, the salt of radium was at first covered with a plate of aluminum 0.1 millimeter in thickness and represented by the sectional line *A A*, which was soldered to the copper. But, after some months of exposure, this plate of aluminum was attacked by the emanations from the radium and pierced by numerous holes, through which the atmospheric moisture could penetrate. In order to remedy this inconvenience, and with the advice of Professor Curie, after having completely dried the capsule, I covered the perforated plate of aluminum with several layers of an excellent varnish, resisting all bad weather.

This operation was performed in December, and since that epoch the apparatus has operated with the greatest regularity. It is, therefore, probable that the plate of aluminum ought to be suppressed in the construction of a new apparatus. You will find the reproduction of two of my daily curves in the Comptes Rendus of the Southport meeting of the International Meteorological Committee, pp. 64 and 65 of the French edition.

The application of radium to the determination of the electric potential at any point in the atmosphere was independently made by several persons; possibly it was first suggested by Prof. F. Exner of Vienna. It undoubtedly constitutes a most convenient substitute for the water dropper, the flame of burning gas, or the various forms of induction apparatus, and it will be worth while for those interested in the subject to look up its earlier bibliography and to ascertain the relative reliability of different methods.

Under date of April 9, Professor Rutherford suggests an improvement on Moureaux's method of exposing the radium and securing it from the influence of the weather, namely, "by inclosing the radium preparation hermetically in a very small thin walled bulb which allows most of the β rays to escape. If the outside of the bulb is silvered and connected with the electrometer, it would act rapidly and should be quite independent of all atmospheric troubles."

As to the relative reliability of various collectors, Linke has shown that the water dropper gives different results or varies in its sensitiveness in proportion to the pressure under which the stream of water is flowing; the greater the pressure the greater the number of small drops formed per second and therefore the greater the sensitiveness. He has also shown that in using a radio-active substance as collector the sensitiveness increases with the increase in the velocity of the wind and the consequent convection of the emanations. The following are a few references to the recent literature of the subject:

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Ebert, H. Über electrische Messungen im Luftballon. Beiträge zur Geophysik, Leipzig. 1903. Band 6. Heft 1. Pp. 66–86.

Henning, F. Vergleichende Messungen des elektrischen Potentiales mittels der Flamme und eines aus radioactiver Substanz bestehenden Collectors. (Contributed February 7, 1902.) Ann. Phys. 4th series. 1902. Vol. 7. Pp. 893–904.

Linke, F. Über Messungen von Potentialdifferenzen mittels Kollektoren unter besonderer Berücksichtigung von radioaktiven Substanzen. Physikalische Zeitschrift. 4. Jahrgang. Oct. 1, 1903. No. 25. Pp. 661–664. (Dated September 15, 1903.)—ED.